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ORIGINAL ARTICLE

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# Failed back surgery syndrome: the role of symptomatic segmental single-level instability after lumbar microdiscectomy

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**Abstract** Segmental instability represents one of several different factors that may cause or contribute to the failed back surgery syndrome after lumbar microdiscectomy. As segmental lumbar instability poses diagnostic problems by lack of clear radiological and clinical criteria, only little is known about the occurrence of this phenomenon following primary microdiscectomy. Retrospectively, the records of 2,353 patients were reviewed according to postoperative symptomatic segmental single-level instability after lumbar microdiscectomy between 1989 and 1997. Progressive neurological deficits increased (mean of 24 months; SD: 12, range 1–70) after the initial surgical procedure in 12 patients. The mean age of the four men and eight women was 43 years (SD: 6, range 40–77). The main symptoms and signs of secondary neurological deterioration were radicular pain in 9 of 12 patients, increased motor weakness in 6 of 12 patients and sensory deficits in 4 of 12 patients. All 12 symptomatic patients had radiological evidence of segmental changes correlating with the clinical symptoms and signs. All but one patient showed a decrease in the disc height greater than 30% at the time of posterior spondylodesis compared with the preoperative images before lumbar microdiscectomy. All patients underwent secondary laminectomy and posterior lumbar sponylodesis. Postoperatively, pain improved in 8 of 9 patients, motor weakness in 3 of 6 patients, and sensory deficits in 2 of 4 patients. During the follow-up period of 72±7 months, one patient required a third operation to alleviate spinal stenosis at the upper end of the laminectomy. Patients with secondary segmental instability following microdiscectomy were mainly in their 40s. Postoperative narrowing of the intervertebral space following lumbar microdiscectomy is correlated to the degree of intervertebral disc resection. It can therefore be concluded that (1) patients in their 40s are prone to postoperative narrowing of the intervertebral disc space and hence subsequent intervertebral instability and (2) that a small extent of intervertebral disc resection and preservation of the "segmental frame" may be beneficial in those patients. The present study demonstrated for the first time that the degree of extensive operative techniques in microdiscectomy increased the risk of subsequent segmental instability. In addition, narrowing of the intervertebral space of more than 30% represents a clear radiological sign of segmental instability.

**Keywords** Microdiscectomy · Disc herniation · Segmental instability · Failed back surgery syndrome · Discectomy · Lumbar spine · Spinal instrumentation

## Introduction

Failure of lumbar microdiscectomy to provide satisfactory long-term pain relief exists in 8 to 25% of the examined patients [21, 27]. Failed back surgery syndrome (FBSS) represents a clinical condition of patients that undergo one or more surgical procedures for lumbosacral disease and present unsatisfactory long-term relief of symptoms, with persistent or recurrent low back pain. The major etiologies of FBSS include inappropriate patient selection/diagnosis, poor operative technique, iatrogenic instability, and surgical complications. There are many different etiological factors that may cause or contribute to FBSS and in every case an exact evaluation of the underlying causes is essential. Although relatively rare, segmental instability represents one of these different factors contributing to FBSS. Segmental instability follows three patterns: (1) lateral rotational instability, (2) postoperative spondylolisthesis or (3) postoperative scoliosis [17]. If extensive, intervertebral movement may cause mechanical deformation of the intraspinal nerve tissue, thereby inducing pain and/or neurological deficits [17]. Even minor instability may cause irritation of receptors related to facet joints or other components of the motion segment, resulting in local pain and/or reflex painful muscular spasm [17]. As the intervertebral joints allow for mobility while providing stability to the spine, interventions at the facet joints, the hemilamina and the ligamentum flavum may change both load-bearing and kinematic characteristics of the spine, possibly increasing the risk for hypermobility, recurrent intervertebral disc herniation, accelerated bone degeneration, and low back pain [14, 13, 20, 24]. However, segmental lumbar instability after microsurgically treated lumbar disc herniation may pose a diagnostic problem, as there is a discrepant occurrence between radiological (20%) and clinical (6%) instability [22], on the one hand, and the lack of clear radiological and clinical criteria, on the other. For this reason, only little is known about the occurrence of this phenomenon following primary microdiscectomy.

The purpose of this study was to determine the role of segmental single-level instability in symptomatic patients following posterior lumbar microdiscectomy, to identify patients with segmental instability predisposing factors for symptomatic postoperative segmental single-level instability and to analyze the relationship between postoperative radiological and clinical signs of symptomatic instability.

## Patients and methods

### Study design

Retrospectively, the records of patients with symptomatic segmental single-level instability and secondary lumbar spondylodesis after lumbar microdiscectomy who underwent surgery between 1989 and 1997 at the University Hospital Basle were reviewed. Reoperation for other causes of FBSS and patients with asymptomatic or more than a single-level segmental instability were excluded from the present study.

### Patient selection

Patients were selected for microdiscectomy based on results of neurological examination, history of radiculopathies refractory to nonoperative treatment and imaging studies [computed tomography (CT), myelography or magnetic resonance (MR)], in correlation with the radiological presence of a single-level lumbar disc disease between L3 and S1. This therapeutic procedure includes a minimum of 4 weeks conservative treatment, including up to 1 week of bed rest, abstention from work and exercise, as well as appropriate prescriptions for nonsteroidal anti-inflammatories, narcotic analgesics and muscle relaxants. With the persistence of pain and particularly in the presence of neurological deficits such as weakness, sensory loss, or an absent deep-tendon reflex secondary to soft disc herniation with or without osteophytes, surgical treatment was thought to be indicated after a minimum of 6 weeks of duration of symptoms. Exclusion criteria for microdiscectomy in this study were significant vertebral instability, myelopathy, systemic infection, active malignancy, acute trauma, or rheumatic disease.

Selection for reoperation for segmental instability included clinical symptomatic patients with clear radiological evidence of instability, as described in the following.

### Clinical evaluation

Before microdiscectomy, flexion–extension radiography of the lumbar spine was performed in every patient. In addition, all patients were studied with a baseline water-soluble myelography, high-resolution CT or MR imaging of the lumbar spine as well. Suspecting a postoperative single-level segmental instability, these imaging studies were repeated. To define the presence of radiological instability, the criteria introduced by Ito were used [12]. In this context, a translation of 3 mm or more on a flexion–extension radiograph was considered to be indicative of instability. Furthermore, plain flexion–extension radiographs were evaluated for the incidence of traction spurs, suggesting instability of the spine according to Knutsson and MacNab [16, 18]. Additional plain radiography of each patient was performed in an upright position: axial traction was accomplished by letting the patient hang his/her hands from a horizontal bar; compression views were taken when the patient had sandbags of approximately 30% of his or her weight on the shoulders.

In addition to the routine physical examination of the back, the patients were evaluated for the presence of clinical instability of the lumbar spine using three criteria [17]: (1) “instability catch”, (2) “painful catch”, and (3) “apprehension”. According to Kotilainen et al. [16], when studying the sign of “instability catch”, the patient was asked to bend the body forward as far as possible and then return to the erect position. The finding was interpreted as abnormal, if the return from the bent position failed because of a sudden attack of low back pain. When studying the sign of “painful catch”, the patient was asked to lift up a straightened leg and lower it then going slowly back on the examination couch. The test was interpreted as abnormal, if the leg suddenly dropped because of a sharp pain in the lower back. The symptom of “apprehension” was positive, if the patient felt a sensation of collapse of the lower back because of a sudden onset of back pain when moving.

### Surgical procedure

The initial operative technique used was similar to that described in the literature using magnification with an operative microscope or loupes as described by Caspar and Klara and Foley [3, 15]. All patients received standard perioperative antibiotic prophylaxis and subcutaneous slow-molecular heparin. After induction of general anesthesia, the patient was placed in the knee–chest position with hip flexion in a 90–90 position. A small paramedian skin incision was made (3–5 cm) at the appropriate level. After incision of the lumbosacral fascia, the paravertebral muscles were stripped from the spinous processes and laminae laterally to the facet joint. Care was taken to avoid injury to the facet capsule. Retraction on one side was accomplished with a self-retraining retractor on the superior facet at the appropriate level. A unilateral laminotomy of both leading and trailing edges at the appropriate interspace was made and the underlying ligamentum flavum excised. This open window was usually 1 to 2 cm in diameter and extended laterally to the facet joint. Bone removal was adequate but not excessive to avoid disarticulation of the inferior facet. Epidural dissection exposed the underlying nerve root. In case of a free herniated fragment, disc fragments could be removed with a microrongeur. To remove a subligamentous disc herniation, the posterior longitudinal ligament had to be incised first. Residual disc material from within the intervertebral disc space could be resected by either incising a window in the annulus or by bluntly retrieving disc material through the annular tear. Caution was mandatory to avoid perforation of the anterior annulus. Careful inspection of the nerve root ventrally, superiorly, and caudally was necessary to rule out residual disc fragments. Occasionally, a foraminotomy was also necessary.

Perioperative or intraoperative findings were assessed using hospital records. The degree of the disc herniation was classified using the grading system described by Spangfort [26] and the extent of this herniation was classified according to Reulen [23].

The spinal instrumentation was used similar to that described by Dick [5]. All patients received standard perioperative antibiotic prophylaxis and subcutaneous slow-molecular heparin. After induction of general anesthesia, the patient was placed in a prone position. By the usual midline posterior approach, the laminae and facet joints were prepared open and the transverse processes localized. The entry point of the screws was found to be appropriate at the level to the middle of the transverse process as far laterally as the lateral border of the upper articular process. After localization of the entry points, wires were inserted parallel to the end plates and convergent 10 to 15° towards the midline through the pedicles into the vertebral bodies to a depth of 3 cm (except in S1, which is considerably smaller). After radiological control by X-ray, the wires were replaced by self-tapping screws that were driven manually into the vertebral bodies until their tip lies close to the anterior wall. Bone grafting was performed after appropriate neural decompression of the concerned level. Donor material for this procedure was autologous iliac crest (cortical-cancellous strips and plugs of cancellous bone). The screws were connected with the rods lying towards the middle in the groove along the spinous processes.

### Outcome evaluation

After microdiscectomy, 98% of the patients were routinely examined postoperatively 2 to 3 months after demission of the surgical department. This routine clinical follow-up examination included different evaluations of the effects on pain and examination of the neurological state. No routine X-ray of the operated lumbar spine was performed, so that no statement regarding the incidence of asymptomatic cases can be drawn. In the further follow-up after this first postoperative outpatient examination, symptomatic patients were evaluated if necessary and the other (asymptomatic) patients were reexamined routinely 12 months after the operation. Three percent of the patients re-evaluated at 2 to 3 months were lost in the follow-up between the first postoperative routine examination (2–3 months postoperatively) and the second postoperative routine examination (12 months postoperatively). Two years after the initial operation, there was detailed information available regarding the neurological state in 89% of the patients. During the whole follow-up period of this study, one patient refused a second surgical procedure and was treated conservatively.

After spinal instrumentation, the postoperative neurological state was evaluated at 2, 6, and 12 months in all patients. Radiological follow-up was performed using conventional plain radiographies and reconstructed CT scans of the lumbar spine at 6 months. At 12 months, flexion–extension X-ray films were obtained. An independent radiologist reviewed all radiographs. Loss of surgically restored disc height and sagittal balance was measured.

### Statistical analysis

Data are reported as the means±SD unless otherwise indicated. Due to the small numbers, the data were not treated statistically.

## Results

### Patient characteristics

During the 9-year period, 12 of 2,353 patients who underwent lumbar microdiscectomy were re-operated for symptomatic one-level segmental instability with progressive neurological deficits. All 12 patients underwent a secondary operative procedure (mean of 24 months; SD: 12, range 1–70) after the initial surgical intervention. The mean age of the four men and eight women was 43 years (SD: 6, range 40–77), with all but one patient aged between 40 and 52 years. The initial discectomy was at L5/S1 in five cases, at L4/5 in four cases and at L4/3 in three cases. Before the first operation, there was no radiographic or clinical instability in any of these 12 patients. Initial distribution of

**Table 1** Distribution of initial disc herniation in relation to the intervertebral foramen of the 12 cases with postoperative single-level segmental instability

| Topographical extension of disc herniation | Segmental instability (*n*=12) |
|---|---|
| Canalicular | 8 (66%) |
| Cranio-posterior-lateral | 2 (16%) |
| Canaliculuar and posterolateral | 2 (16%) |
| Canalicular and extracanalicular | 0 |

**Table 2** Surgical approach in the 12 patients with postoperative single-level segmental instability compared to the whole collective

| Initial surgical approach | Segmental instability (*n*=12) | Whole collective (*n*=2,353) |
|---|---|---|
| Interlaminar fenestration | 8% | 91% |
| Hemilaminectomy | 92% | 9% |
| Monosegmental approach | 58% | 87% |
| Bisegmental approach | 42% | 13% |
| Monsegmental discectomy | 67% | 90% |
| Bisegmental discectomy | 33% | 10% |

disc herniation of the patients with postoperative single-level segmental instability is summarized in Table 1. It can be demonstrated that 10 of 12 patients demonstrated at least some canalicular involvement in the extent of the disc herniation. The extent of the initial surgical procedure differs between the patients with postoperative single-level segmental instability and the whole collective (Table 2). A more extensive surgical procedure with partial or complete resection of the facet joints and/or the hemilamina was associated with higher risk of postoperative instability.

## Interval between first and second operation

Six of the 12 patients (50%) had no pain relief after the first operation until the second operation. In two patients (17%), the pain was reduced within the first month after the first operation (mostly in association with forced physiotherapy), in 25% between the second and sixth month, and in 8% between the seventh and twelveth month.

## Patient data at second operation

The main symptoms and signs of secondary neurological deterioration were a predominant radicular pain in 9 of 12 patients (75%), increased motor weakness in 6 of 12 (50%) patients and sensory deficits in 4 of 12 patients (33%). Various symptoms and signs of segmental instability were found in all patients. The sign of “instability catch” was positive in 10 of 12 (83%) patients, “apprehension” in 8 of 12 patients (66%), and “painful catch” in 6 of 12 (50%). All three criteria of instability were positive in 4 of 12 (33%) patients; two criteria were positive in 4 of 12 (33%) and one criterion was positive in 4 of 12 (33%). There was no correlation between neurological signs (radicular pain, motor weakness, sensory deficits) and clinical signs of instability (instability catch, apprehension, painful catch). There was no correlation between subsequent clinical signs of instability in the follow-up and the degree of disc herniation at the time of the first operation.

All 12 patients had radiological evidence of segmental changes correlating to the clinical symptoms and signs (Table 3). The signs of instability were related to the operated level in 11 of 12 patients (92%) and to the adjacent level in 1 of 12 patients (8%). Flexion–extension radiography demonstrated an increased translation during lateral bending as a indication of instability in 9 of 12 patients (75%), traction spurs of the vertebrae were found in 4 of 12 patients (33%). All but one patient showed a decrease in the disc height greater than 30% before the time of spondylodesis compared with the preoperative neuroradiological images before lumbar microdiscectomy (Table 4). In the one patient without a decrease in disc height greater than 30%, the interval between the first operation and re-operation for spinal instrumentation was only 1 month. This decrease in disc height on X-rays correlated with the decrease in the signal intensity or an expansion of the cleft of the disc on T2-weighted MR images, in all but one case in which diagnosis could only be made by MR images alone. There was a correlation between the decrease in the disc height and the grade of radiological instability (Table 4). In addition, there was also a correlation between the severity of clinical signs of instability (instability catch, apprehension, painful catch) and the decrease in disc height. A provocative discography was only performed in 3 of the 12 patients (25%; two with 40% and one with 50% decrease in disc height), but showed no additional information related to MR imaging or X-rays.

**Table 3** Radiological findings of clinical symptomatic instability

| Findings | Radiological intervertebral instability | |
|---|---|---|
| | Increased translation ($n$=9) | Traction spurs ($n$=4) |
| Instability catch | 7 (78%) | 3 (75%) |
| Painful catch | 5 (55%) | 1 (25%) |
| Apprehension | 4 (44%) | 2 (50%) |

**Table 4** Decrease in disc height related to intervertebral instability in symptomatic cases

| Decrease in disc height[a] | Intervertebral instability[b] | | |
|---|---|---|---|
| | Small (10°–20°) | Moderate (20°–30°) | Large (>30°) |
| 20% | 1 | N/A[c] | N/A |
| 30% | 2 | N/A | N/A |
| 40% | N/A | 2 | N/A |
| 50% | N/A | 3 | 1 |
| 60% | N/A | N/A | 2 |
| 70% | N/A | N/A | 1 |

[a]According to Mochida et al. [19] a decrease greater than 30% of the preoperative value was diagnosed as having a narrowing change
[b]An angle of the intervertebral space greater than 10° flexion and extension was defined as instability
[c]N/A, not applicable

## Postoperative outcome after second operation (spinal instrumentation)

All 12 patients underwent secondary decompressive posterior laminectomy and posterior lumbar interbody fusion with pedicle screw fixation using structural autograft. The originally exposed disc interspace was re-explored in 11 of 12 patients (92%). In these patients, postoperative scarring or fibrosis of the initial operation was found in 8 of 11 patients (67%), no obvious pathological findings in 2 of 11 patients (18%), and true recurrent disc herniation in 1 of 11 patients (9%). There was a correlation between intraoperative scarring/fibrosis as found during the second operation and the degree of radiological decrease in disc height before the second operation. After spinal instrumentation, pain improved in 8 of 9 patients (89%), motor weakness in 3 of 6 patients (50%), and sensory deficits in 2 of 4 patients (50%). At 3 months postoperatively, none of the 12 patients presented any clinical signs of instability. During the follow-up period of 72±7 months, one patient required a third operation to alleviate spinal stenosis at the upper end of the laminectomy. A solid fusion could be achieved in all but one case (92%) after 12 months. The range of kyphosis was 2° to 4°.

## Discussion

Extensive laminectomy in the treatment of spinal stenosis has been well documented to potentate spinal instability [7, 10]. The present study was conducted to evaluate the possibility that lumbar microdiscectomy may increase the risk of the development of single-level instability, since there are only limited data on the development and progression of spinal instability after lumbar disc surgery [11, 17, 19]. In this study, it could be demonstrated for the first time that extensive operative methods in disc surgery increased the risk of subsequent segmental instability.

According to Mochida et al. [19],postoperative narrowing of the intervertebral space following lumbar microdiscectomy is correlated to the degree of disc removal. They conclude that the younger the patient treated with massive extirpation of the disc material, the more frequently a decrease in the disc height and an increase in the intervertebral instability are seen [19]. Intervertebral disc space narrowing can progress up to 3 to 6 months after microdiscectomy [11]. However, some authors contend that if an extensive extirpation of the disc is not performed, the patient risks a relapse of the remaining nucleus pulposus and possibly a secondary hernitomy [28]. The present data show a trend towards a positive correlation of the degree of postoperative narrowing of the intervertebral space and the degree of segmental instability. This means that the remaining nucleus pulposus at the central area of the disc plays an important role in maintaining the disc height and preventing the abnormal instability. However, the present MR images show that only disc space collapse produces symptoms of segmental instability and not as one could argue the internal derangement of the disc alone or simply the age-related changes of degenerative disc disease. On the basis of the present postoperative MR image follow-up, one may suggest that extensive disc removal is not entirely harmless to the disc itself and it may be important to maintain the intervertebral disc function. For this reason, it can be suggested from our series that the removal of disc material should be moderate to prevent later FBSS of patients in their fourth and fifth decades of life. In older patients, the often-present degenerative changes of the spine may allow a more extensive microdiscectomy with less danger of further segmental instability. However, the primary implantation of cages may prevent segmental instability after extensive discectomy in younger patients, but no data exist to underline this hypothesis.

Lumbar instability can be verified both clinically and radiologically. Due to the lack of clear diagnostic signs in clinical and radiological examination, there was a poor correlation between both in the present series. Many investigators have attempted to define lumbar spinal instability [1, 6, 12, 13, 14, 16, 17, 18, 20]. It is clear that the levels of spinal segmental instability show abnormally increased motion on radiography and for this reason biomechanical criteria may be useful. Adams and Hutton [1] found the following percentage contributions by various structures in the prevention of sagittal translation: intact facet capsules (39%), intact disc and annulus (29%), the supraspinous and interspinous ligaments (19%) and the ligamentum flavum (13%). Conversely, if the differences between the normal discs and the abnormal discs in the relationship between disc geometry and deformation are taken into consideration, spinal segmental instability can also be defined as the breakdown of this close relationship [12]. These criteria allow one to distinguish patients with postoperative lumbar segmental instability from patients with other etiologies of FBSS. In addition, it has been often hypothesized, although hitherto never definitively proven, that extensive operative methods in disc surgery may increase the risk of subsequent segmental instability. The present study is the first to demonstrate that the pars interarticularis, as important structures for lumbar spine stability, should be preserved intraoperatively, whenever possible. It could be demonstrated in the present series that the "segmental frame" consisting of the facet joint, the hemilamina and the ligamentum flavum after microdiscectomy at the lumbar level is preserved.

In addition, our data suggest that narrowing of the intervertebral space of more than 30% is a clear radiological sign of segmental instability requiring further surgical procedures. However, we could show that flexion–extension radiographs together with the MR images give sufficient information for adequate evaluation of the surgical indication and that the invasive discography plays no role in the diagnosis of segmental instability at the present time. The clinical signs alone did not correlate with the standard radiological signs of segmental instability. It seems that the aggravation of clinical symptoms is influenced not only by instability, but also by other factors such as postoperative scarring and abnormal callus formation at the site of operation [10]. For this reason, the recommendation to perform a spondylodesis after discectomy is derived from the principal consideration that the insertion of spondylodesis material leads to permanent neuroforaminal widening [8, 9]. The additional posterior laminectomy helps to widen the foraminal stenosis caused by mechanic deformation, but has no adverse effect on postoperative stability after lumbar spondylodesis. The results of treatment for segmental instability have been fairly good, achieving 74 to 94% fusion rates and 75 to 90% good to excellent clinical outcomes [4].

Although our series of segmental instability after lumbar microdiscectomy is small, we found that patients with secondary segmental instability following microdiscectomy were mainly in their forties. Postoperative narrowing of the intervertebral space following lumbar microdiscectomy is correlated to the degree of disc removal. We therefore conclude that (1) patients in their forties are prone to postoperative narrowing of the intervertebral disc space and hence intervertrebral instability and (2) that a less extensive disc removal and preservation of the "segmental frame" may be beneficial in those patients. In addition, narrowing of the intervertebral space of more than 30% is a clear radiological sign of segmental instability.

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